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SHORT REPORT

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Accuracy and safety of dry needling placement in the popliteus muscle: A cadaveric study

Jacobo Rodríguez-Sanz[1,2*] | Albert Pérez-Bellmunt[1,2*] | Carlos López-de-Celis[1,2] | Cesar Hidalgo-García[3] | Shane L. Koppenhaver[4] | Max Canet-Vintró[1,2] | César Fernández-de-las-Peñas[5,6]

[1]Faculty of Medicine and Health Sciences, Universitat Internacional de Catalunya (UIC-Barcelona), Barcelona, Spain

[2]ACTIUM Functional Anatomy Group, Barcelona, Spain

[3]Faculty of Health Sciences, Universidad de Zaragoza, Zaragoza, Spain

[4]Baylor University Doctoral Program in Physical Therapy, Waco, TX, USA

[5]Department of Physical Therapy, Occupational Therapy, Physical Medicine and Rehabilitation, Universidad Rey Juan Carlos (URJC), Alcorcón, Madrid, Spain

[6]Cátedra Institucional en Docencia, Clínica e Investigación en Fisioterapia: Terapia Manual, Punción Seca y Ejercicio Terapéutico, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain

Correspondence
César Fernández de las Peñas, Facultad de Ciencias de la Salud, Universidad Rey Juan Carlos, Avenida de Atenas s/n, 28922 Alcorcón, Madrid, Spain.
Email: cesarfdlp@yahoo.es; cesar.fernandez@urjc.es

Abstract

Background: The popliteus muscle attaches posteriorly to the joint capsule of the knee. Although it is an important rotational stabiliser and has been implicated in various knee pathologies, research on its treatment with dry needling is scarce.

Objective: To determine if a needle accurately and safely penetrates the popliteus muscle during the clinical application of dry needling.

Methods: A cadaveric descriptive study was conducted. Needling insertion of the popliteus muscle was conducted in 11 cryopreserved cadavers with a 50-mm needle. The needle was inserted at upper third of the posterior part of the tibia closest to the knee towards the popliteus. The needle was advanced into the muscle based upon clinician judgement. Cross-sectional anatomical dissections were photographed and analysed by photometry. Safety of the intervention was assessed by calculating the distance from the tip of the needle to the proximate neurovascular structures.

Results: Accurate needle penetration of the popliteus muscle was observed in 10 out of 11 (91%) of the cadavers (mean needle penetration: 25.7 ± 6.7mm, 95% CI 21.3-30.3 mm). The distances from the tip of the needle were 17±6mm (95% CI 13-21 mm) to the tibial nerve and 15 ± 0.7mm (95% CI 10-20 mm) to the popliteus vascular bundle.

Conclusion: The results from this cadaveric study support the notion that needling of the popliteus can be accurately and safely conducted by an experienced clinician. Future studies investigating the clinical effectiveness of these interventions are needed.

1 | INTRODUCTION

The use of dry needling among clinicians has increased in clinical practice recently; however, the occurrence of adverse events suggests the need for research to identify potential risks of this intervention.[1] Evidence suggests that most adverse events related to dry needling can be considered as minor (eg mild bleeding, bruising and pain during the intervention); however, more serious events

Jacobo Rodríguez-Sanz and Albert Pérez-Bellmunt have equal contribution.

such as pneumothorax or lasting nerve damage, can also occur.[2] Knowledge of anatomical landmarks and location of deeper anatomic structures are the key to a safe application of dry needling; however, its application to deep musculature is controversial because of the possibility of inadvertently needling proximate neurovascular structures.

The popliteus is a flat muscle that forms the lower part of the popliteal fossa at the posterior part of the knee joint. It originates proximally and laterally in a depression on the outer posterior side of the lateral condyle of the femur and inserts into the proximal attachment of the lateral collateral ligament on the lateral epicondyle of the femur.[3] The popliteus is the only muscle that attaches posteriorly within the joint capsule of the knee converting it into an important rotational stabiliser of the knee.[4]

Dysfunction of the popliteus muscle is often underappreciated and is generally secondary to trauma. Some case reports have described diffuse knee pain associated with popliteus strain,[5,6] tendon tenosynovitis[7] or intra-substance rupture of its tendon.[8] The popliteus muscle can also be overloaded after knee trauma involving a tear of the posterior cruciate ligament.[9] Some authors also propose that the presence of trigger points in the popliteus muscle can represent an underdiagnosed cause of diffuse knee pain.[10] In fact, active trigger points in the popliteus muscle have been found to be present in 17% of individuals with painful knee osteoarthritis.[11] Dry needling of the popliteus is performed clinically but has been minimally investigated. A recent case report described a successful application of dry needling to the popliteus muscle in an adolescent ballet dancer.[12]

Data on the ability of clinicians to accurately and safely reach the popliteus muscle with a dry needle are scarce. This information seems especially important because of the proximity of this muscle with that of the tibial nerve and popliteus vascular bundle.[3] No anatomical study has investigated if a solid filament needle, as clinically used with dry needling, can accurately and safely penetrate the popliteus muscle. Therefore, the aims of this study were (a) to determine if a solid needle is able to accurately penetrate the popliteus, and (b) to determine the safety of the procedure by calculating the distance between the needle and the neurovascular structures using a cadaver model.

What's known

- The occurrence of adverse events during application of dry needling suggests the need for research identifying potential risks of this intervention.
- Data on the ability of clinicians to accurately and safely reach the popliteus muscle with a dry needle are scarce.

What's new

- This is the first to investigating the accuracy and safety of needling the popliteus muscle.
- This cadaveric study found that a solid needle pierced the popliteus with an accuracy of 91% supporting.
- The distance from the tip of the needle was 17 ± 6 mm (95% CI 13-21 mm) to the tibial nerve and 15 ± 0.7 mm (95% CI 10-20 mm) to the popliteus vascular bundle.

Message for the clinic

- This cadaveric study supports the notion that dry needling to the popliteus muscle can be accurately and safely conducted when applied by an experienced clinician closed to the upper third of the tibia.

FIGURE 1 Illustration of needling insertion of the popliteus muscle

2 | METHODS

2.1 | Cadaveric sample

The cadaveric sample consisted of cryopreserved legs donated to an institutional university anatomy laboratory in Barcelona (Spain). The study was approved by the Local Ethics Committee of the Anatomy Laboratory (CBA-2020-2). All cadavers were visually checked for evidence of prior surgery, trauma or any anatomical abnormalities that would influence the dissections. The frozen samples were stored at −20°C and were thawed at room temperature 24h prior to the experiment.

2.2 | Needling procedure

A clinician with more than 10 years of experience with dry needling performed all procedures. Sterile stainless-steel needles with a plastic cylindrical guide, 50mm in length and 0.32mm calibre were used. Needling insertion was performed targeting the popliteus using a common clinical technique as follows: with the knee flexed approximately at 90°, the needle was inserted from a medial to lateral direction in the upper third of the tibia

closest to the knee and angled anteriorly towards the posterior aspect of the tibia (Figure 1). The needle was kept as closest as possible to the posterior aspect of the tibia bone and advanced to a depth judged clinically to be most likely into the popliteus muscle.[13]

2.3 | Anatomical procedure

Once the needle was inserted, latex was injected to mark where the tip of the needle was located to determine the accuracy of the insertion into the popliteus muscle. Cross-sectional anatomical dissections were photographed and then analysed by photometry in order to calculate the following distances in relation to the neurovascular bundle (Figure 2):

1. Needle tip to nerve distance (A): The distance (mm) between the tip of the needle and the tibial nerve.
2. Needle tip to vascular bundle distance (B): The distance (mm) between the tip of the needle and the closest branch of the popliteal vascular bundle.

We also assessed the depth of needle penetration, that is the length of the needle inserted to reach the popliteus muscle (mm).

3 | RESULTS

Needling of popliteus muscle was conducted on 11 cryopreserved legs (5 females, 6 males; mean age: 70, SD: 16 years, 7 left/4 right legs). Anatomic dissection revealed that the tip of the needle pierced the belly of the popliteus muscle in 10 out of 11 legs (accuracy of 91%). The needle was inserted a mean of 25.7mm ± 6.7mm (95% CI 21.3-30.3 mm) to reach the popliteus muscle (Figure 3).

No neurovascular bundles were pierced in any of the cadavers. The distances from the tip of the needle to the neurovascular structures were 17mm ± 6mm (95% CI 13-21 mm) to the tibial nerve (A) and 15mm ± 0.7mm (95% CI 10-20 mm) to the popliteus vascular bundle (B).

4 | DISCUSSION

The results of this cadaveric study found that a solid needle pierced the popliteus muscle with an accuracy of 91% supporting the notion that this deep muscle can be properly targeted with a needle during clinical application of dry needling. Additionally, this study also supports the potential safety of this procedure as no neurovascular structures were pierced in any of the cadavers, and the needles were a mean of 17 and 15 mm away from the tibial nerve and popliteus vessels, respectively.

These results are important as the popliteus is not accessible to direct palpation because of its anatomical location; therefore, dry needling may represent a proper therapeutic approach for targeting this muscle. Although this study did not evaluate the effectiveness of dry needling, a meta-analysis has found low to moderate quality evidence supporting a positive effect of lower extremity dry needling on pain and related disability in individuals with patellofemoral pain.[14] Unfortunately, no study included in this meta-analysis applied dry needling to the popliteus muscle. Future randomised clinical trials including dry needling of the popliteus muscle are needed to determine the clinical effectiveness of this intervention.

Our results also support the safety of the needling procedure for the popliteus muscle. We assessed the distances from the tip of the needle to the surrounding neurovascular bundle potentially sensible to damage. Current data suggest a mean distance of 15mm from the needle to the neurovascular bundle. Considering that the needle was inserted a mean of 26mm into the muscle but no further than 30mm, the 'safety' distance to the tibial nerve and the popliteus vascular bundle is

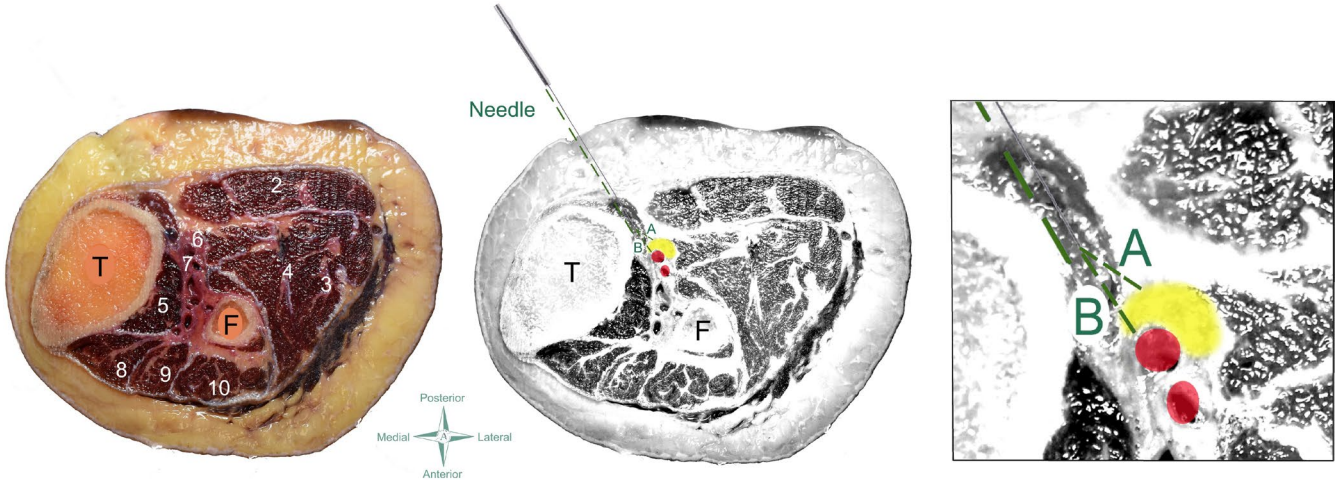

FIGURE 2 Scheme of the needling procedure on a cadaver (left) and anatomical draw (centre and right). T: Tibia; F: Fibula; 1: Popliteus muscle; 2: internal gastrocnemius muscle; 3: lateral gastrocnemius muscle; 4: soleus muscle; 5: tibial posterior muscle; 6: tibialis nerve; 7: popliteus vessels; 8: tibialis anterior muscle; 9: extensor digitorum longus muscle and 10: peroneus longus muscle. (A) distance needle tip-tibial nerve; (B) distance tip needle-vascular bundle

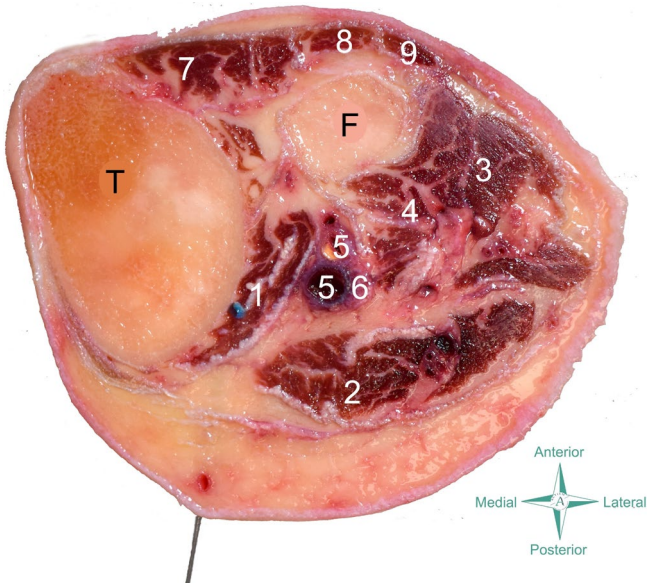

FIGURE 3 Anatomical study showing that the tip of the needle (blue latex point) targets the popliteus muscle. T: Tibia; F: Fibula; 1: Popliteus muscle; 2: internal gastrocnemius muscle; 3: lateral gastrocnemius muscle; 4: soleus muscle; 5 popliteal vessels; 6: tibial nerve; 7: tibialis anterior muscle; 8: extensor digitorum longus muscle and 9: peroneus longus muscle

around 50% of this penetrating distance of the needle. Nevertheless, clinicians should carefully control angulation and penetration of the needle when targeting the popliteus muscle since this muscle is close to the neurovascular bundle near the posterior part of the tibia.[13]

Overall, the current cadaveric study supports the notion that the clinical application of dry needling into the popliteus muscle, if applied by an experienced clinician, is accurate and safe. However, some limitations should be also recognised. First, dissections were conducted on 11 single legs and the accuracy was 91%. Because of the relatively small sample size, no gender or anthropometric differences in needle placement were assessed. These differences likely exist as supported by a recent ultrasound study examining the depth of the needle for targeting the soleus muscle.[15] Second, as with most needling approaches, manual identification of superficial anatomic landmarks is requisite for successful needle insertion into a targeted muscle. It should be recognised that the popliteus muscle could be difficult to locate for novice clinicians. Since all the needle insertions in this study were conducted by a highly experienced clinician, the role of experience in the accuracy and safety of this procedure should be investigated in future studies.

In conclusion, this cadaveric study supports the notion that dry needling to the popliteus muscle can be accurately and safely conducted when applied by an experienced clinician.

DISCLOSURES

The authors declared no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the results of this study are available from the corresponding author, upon reasonable request.

ORCID

Jacobo Rodríguez-Sanz https://orcid.org/0000-0003-0419-1943
Albert Pérez-Bellmunt https://orcid.org/0000-0002-5607-0708
Carlos López-de-Celis https://orcid.org/0000-0002-9524-4248
Cesar Hidalgo-García https://orcid.org/0000-0001-7667-2178
César Fernández-de-las-Peñas https://orcid.org/0000-0003-3772-9690

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